Appearance of microvascular obstruction on early vs. delayed contrast imaging following primary PCI

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Introduction

Microvascular obstruction (MO) is a feature of 20-40% of reperfused ST-elevation acute myocardial infarction (STEMI) and confers adverse prognosis. Different CMR sequences are commonly used to detect MO: first pass perfusion (FPP), early gadolinium enhancement (EGE), and late gadolinium enhancement (LGE). FPP and EGE are more sensitive than LGE for the detection of MO, but only MO measurement by LGE has been shown to confer prognostic information. It is unclear whether these three methods detect separate pathologies, or whether differences in MO appearances merely reflect contrast distribution over time. We aimed to determine how appearances between these methods are related.

Methods

60 patients with reperfused first STEMI underwent CMR at 3.0T (Philips Achieva TX with 32-channel cardiac coil) within 3 days of primary percutaneous coronary intervention. MO imaging was performed at identically-planned basal, mid-ventricular and apical short-axis slices. FPP imaging was performed during administration of 0.1 mmol/kg Gd-DTPA contrast using a spoiled turbo gradient echo sequence (TR/TE/flip angle 2.8ms/1.3ms/15°; saturation prepulse delay 100ms per slice, spatial resolution 2.1×2.1×10mm). 4 minutes after contrast administration, EGE imaging was performed (inversion recovery-prepared T1 weighted gradient echo, TR/TE/flip angle 3.7/2.0/25°, TI 450ms, spatial resolution 1.54×1.75×10mm). LGE imaging was performed at both 10 minutes and at 20 minutes (acquisition as per EGE, inversion time adjusted according to Look-Locker scout).

MO was identified as a dark core within infarcted myocardium, and contoured manually by a cardiologist blinded to the results of the other sequences.

We compared area and transmural extent of MO for each method on a per-patient and a per-slice basis.

Results

29 patients (48%) had MO. All patients with MO on LGE also had MO on FPP or EGE, whereas LGE at 10 minutes failed to detect MO in 9 patients (31%) with MO on FPP, and 8 patients (28%) on EGE (Table 1). Of 13 patients with MO volume <5ml on FPP, 12 (92%) had no MO visible on LGE at 20 minutes.

The average visible area of MO per slice decreased with time of measurement ($p<0.001$ for trend, Figure 1). MO area by FPP and EGE correlated with LGE at 20 minutes ($r=0.80$, $p<0.001$ and $r=0.80$, $p<0.001$) but MO volume per patient by FPP and EGE was on average 236% and 200% larger than LGE. Decrease in MO volume over time correlated strongly with size of MO ($r=0.95$, $p<0.01$, Figure 2) and transmural extent of MO ($r=0.77$, $p<0.01$).

	Number of patients with MO	Mean volume of MO (ml, ± SEM)
FPP (2 minutes)	29 (100%)	6.2 ± 1.3
EGE (4 minutes)	28 (97%)	5.4 ± 1.2
LGE (10 minutes)	20 (69%)	3.7 ± 0.9
LGE (20 minutes)	18 (62%)	2.7 ± 0.7

Table 1. Number of patients and mean volume of MO per patient at 4 time points following contrast administration.

Conclusions

The reduction in visible MO is proportional to the extent of MO and time from contrast administration. Given the high correlation, a physical factor such as contrast diffusion into the MO zone may be responsible for reduction in MO size between time points, rather than differing clinical or imaging factors. Small areas of MO on EGE and FPP become undetectable on LGE, while larger areas are detectable but smaller on LGE. MO by LGE identifies more extensive MO than FPP or EGE. If LGE detects patients with larger MO volumes, this may explain its higher predictive value over MO detected by FPP or EGE.

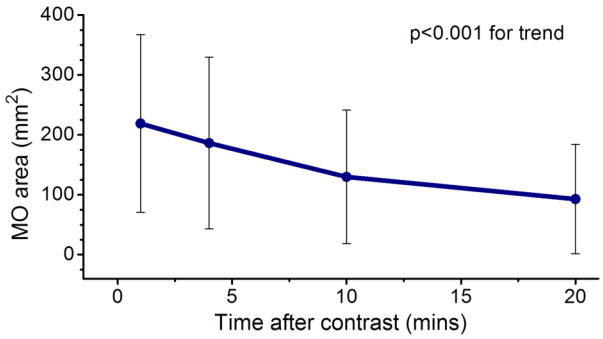

Figure 1. Decrease in apparent visible area of microvascular obstruction per slice after administration of contrast.

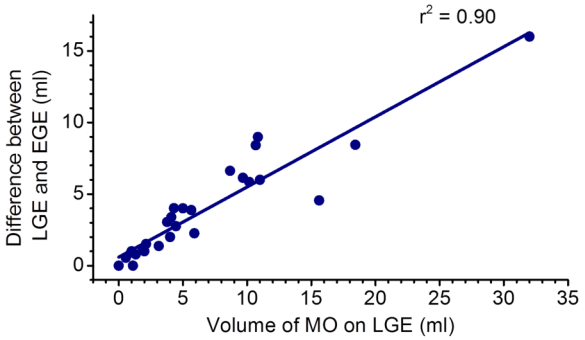

Figure 2. Change in microvascular obstruction volume observed over time is closely correlated with volume of MO.